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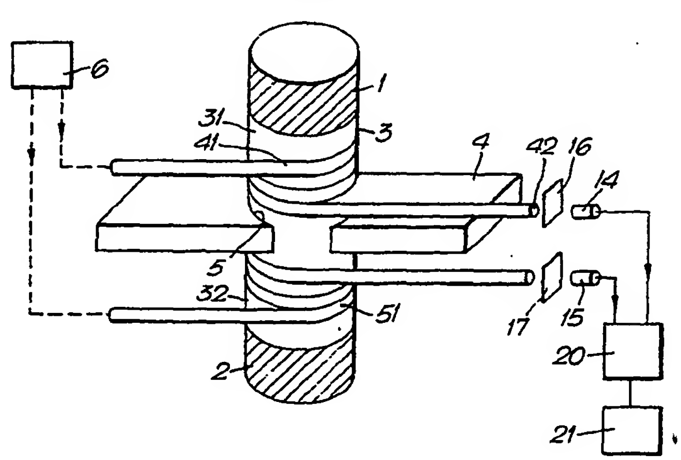
(54) **Accelerometers.**

(57) An accelerometer includes a compliant cylinder 3 supported midway along its length and has equal masses 1 and 2 at opposite ends. Two birefringent optical fibres 41 and 51 with elliptical cores 42 are wound around the cylinder 3 in opposite senses on opposite sides of the support 4. Radiation from a source 6 is supplied to one end of both fibres 41 and 51 and emerges from the opposite end where it is supplied to respective photodiodes 14 and 15 via respective polarizers 16 and 17. Acceleration axially of the cylinder 3 causes extensive strain in one fibre and compressive strain in the other which causes equal and opposite changes in birefringence. A processor 20 subtracts the change in outputs of the photodiodes 14 and 15 to provide an acceleration output that is independent of temperature.

Fig.1.



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ACCELEROMETERS

This invention relates to accelerometers.

The invention is more particularly concerned with accelerometers for providing an optical output.

It is an object of the present invention to provide an accelerometer that can provide an optical output which is independent of the effects of temperature change.

According to the present invention there is provided an accelerometer characterised in that the accelerometer includes first, and second compliant members having respective axes arranged parallel with one another, a support that supports the compliant members at a first end, a first mass mounted at the second end of the first compliant member, a second mass identical with the first mass mounted at the second end of the second compliant member opposite the first mass, first and second optical fibres exhibiting birefringence wound around respective ones of the compliant members such that acceleration axially of the compliant members compresses one of the compliant members and extends the other compliant member so as to produce equal and opposite changes in birefringence in the first and second optical fibres, and a processor responsive to the change in birefringence of both fibres that produces an output representative of acceleration which is independent of temperature.

The first and second compliant members are preferably arranged axially of one another with the first end of the compliant members adjacent one another. The first and second compliant members are preferably provided by opposite ends of a compliant cylinder supported midway along its length. The cylinder may be of circular section. The compliant members may be of an elastomeric material. The first and second optical fibres preferably both have a core of elliptical section, the major axis of the elliptical section of each fibre extending parallel to the axis of the compliant members.

The accelerometer may include a source of radiation that supplies radiation to one end of both optical fibres, a first detector located to receive radiation from the opposite end of the first optical fibre, a second detector located to receive radiation from the opposite end of the second optical fibre. The accelerometer may include a first polarizer located between the opposite end of the first optical fibre and the first detector, and a second polarizer located between the opposite end of the second optical fibre and the second detector, the first and second polarizers being oriented such that a maximum level of radiation is incident on the detectors for a minimum applied acceleration. The accelerometer preferably includes a processor connected with the first and second detectors, the processor determining for each fibre, the change in values of birefringence cause by applied acceleration and subtracting these values from one another.

An accelerometer according to the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective, schematic view of the accelerometer; and

Figure 2 is a partly cut-away view of a part of the accelerometer to a larger scale.

The accelerometer includes two, identical masses 1 and 2 mounted at opposite ends of a solid, circular section cylinder 3 of a compliant, resilient material such as an elastomeric rubber or plastics. The cylinder 3 is supported by a rigidly fixed plate or support 4 with a central aperture 5 that embraces the cylinder 3 around its circumference, midway along its length. In this way, the cylinder is effectively divided into two members 31 and 32 of equal length which are axially aligned with one another.

Around the upper member 31 is closely wound a length of a highly birefringent fibre 41 having a core 42 of elliptical section. In the drawings, for simplicity, there are only shown three windings of the fibre 41 although, in practice, many more windings would be used. The fibre 41 is wound such that, in section, the major axis of a cross section through the elliptical core 42 extends parallel to the axis of the cylinder 3 and such that the major axis of each winding of the fibre align with one another (Figure 2). An identical fibre 51 is wound around the lower compliant member 32.

One end of both fibres 41 and 51 extends to a source 6 of optical radiation. The other end of both fibres 41 and 51 extends to a respective detector, such as a photodiode 14 and 15, via respective polarizers 16 and 17. The polarizers 16 and 17 are oriented relative to the core of the fibre 41 and 51 such that they give a maximum transmission to the photodiodes 14 and 15 when there is a zero or minimum acceleration applied to the accelerometer. The electrical output from each photodiode 14 and 15 is supplied to a processing unit 20 which provides an output signal, representative of acceleration, to a display or other utilization device 21.

Alternatively, the two fibres 41 and 51 could be multiplexed using a single source and detector by means of modulation/demodulation elements.

In use, acceleration with a downward component along the axis of the cylinder 3 will compress the upper member 31 and extend the lower mem-

ber 32. This thereby results in an increase in the diameter of the upper member 31 and a decrease in diameter of the lower member 32. The two fibres 41 and 51 both consequently experience axial strain as a result of the changes in circumference of the upper and lower portions of cylinder 3. The axial strain in the two fibres 41 and 51 will, however, be of opposite kinds; the strain in the upper fibre is extensive, whereas that in the lower fibre is compressive. The winding of the fibres 41 and 51 is such that the orientation of the fibres' internal optical axes ensures that the externally induced birefringence, caused by axial stresses on the fibres, enhances the fibres internal birefringence. Any stresses in the fibres 41 and 51 would alter the relative intensities of radiation polarized along different, orthogonal axes where the radiation emerges from the ends of the fibres. This consequently causes a change in the intensity of radiation passed by the polarizers 16 and 17 and hence a change in the radiation incident on the detectors 14 and 15. The effect of acceleration on the outputs of the detectors 14 and 15 will be of equal magnitude but complementary, that is, the output of one detector 14 will increase by an amount equal to that by which the output of the other detector 15 decreases. The effect of a change in temperature will, however, be an identical change in the outputs of the two detectors 14 and 15.

The processing unit 20 provides a reading for both detectors 14 and 15 in accordance with changes in their outputs from the zero acceleration state. In order to compensate for any change in temperature, the processing unit 20 subtracts these two readings from one another before deriving the output to the display 21.

The sensitivity of the accelerometer to acceleration is dependent on several factors such as the nature of the compliant cylinder, the size of the mass and so on. The accelerometer can therefore, be modified for different requirements by change in its mechanical components.

It will be appreciated that is not essential to use a single compliant cylinder 3 but that the two portions 31 and 32 could be separate compliant members with parallel axes and preferably arranged axially of each other.

Claims

1. An accelerometer characterised in that the accelerometer includes first and second compliant members (31 and 32) having respective axes arranged parallel with one another, a support (4) that supports the compliant members at a first end, a first mass (1) mounted at the second end of the first compliant member (31), a second mass (2) identical with the first mass (1) mounted at the second end of the second compliant member (32) opposite the first mass, first and second optical fibres (41 and 51) exhibiting birefringence wound around respective ones of the compliant members such that acceleration axially of the compliant members compresses one of the complaint members and extends the other compliant member so as to produce equal and opposite changes in birefringence in the first and second optical fibres, and a processor (20) responsive to the change in birefringence of both fibres (41 and 51) that produces an output representative of acceleration which is independent of temperature.

2. An accelerometer according to Claim 1, characterised in that the first and second compliant members (31 and 32) are arranged axially of one another with the first end of the compliant members adjacent one another.

3. An accelerometer according to Claim 1 or 2, characterised in that the first and second compliant members (31 and 32) are provided by opposite ends of a compliant cylinder (3) supported midway along its length.

4. An accelerometer according to Claim 3, characterised in that the cylinder (3) is of circular section.

5. An accelerometer according to any one of the preceding claims, characterised in that the compliant members (31 and 32) are of an elastomeric material.

6. An accelerometer according to any one of the preceding claims, characterised in that the first and second optical fibres (41 and 42) both have a core (42) of elliptical section, and that the major axis of the elliptical section of each fibre extends parallel to the axis of the compliant members (31 and 32).

7. An accelerometer according to any one of the preceding claims, characterised in that the accelerometer includes a source (6) of radiation that supplies radiation to one end of both optical fibres (41 and 51), a first detector (14) located to receive radiation from the opposite end of the first optical fibre (41), a second detector (15) located to receive radiation from the opposite end of the second optical fibre (51).

8. An accelerometer according to Claim 7, characterised in that the accelerometer includes a first polarizer (16) located between the opposite end of the first optical fibre (41) and the first detector (14), and a second polarizer (17) located between the opposite end of the second optical fibre (51) and the second detector (15), and that the first and second polarizers (16 and 17) are oriented such that a maximum level of radiation is incident on the detectors (14 and 15) for a minimum applied acceleration.

9. An accelerometer according to Claim 7 or Claim

8, characterised in that the accelerometer includes a processor (20) connected with the first and second detectors (14 and 15), and that the processor determines for each fibre (41 and 51), the change in values of birefringence cause by applied acceleration and subtracts these values from one another.

Fig.1.

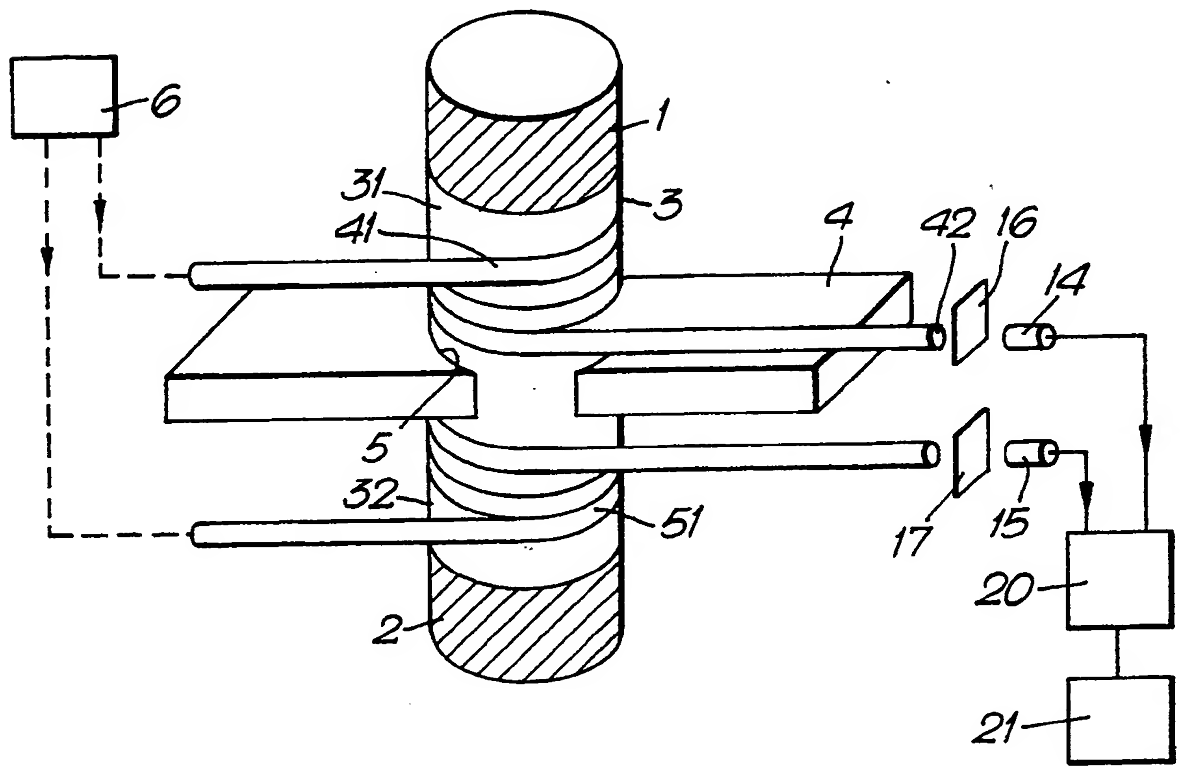
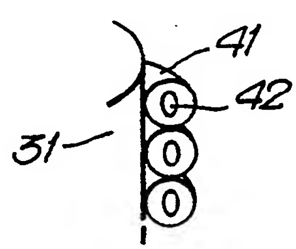


Fig.2.



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EUROPEAN SEARCH REPORT

Application Number

EP 90 31 0130

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 799 752 (E.F. CAROME) * Column 6, line 63 - column 8, line 47; figures 5,6 * - - -	1,7	G 01 P 15/08 G 01 P 1/00
A		2,4	
A	US-A-4 442 350 (S.C. RASHLEIGH) * Column 8, lines 19-47; figures 10,11 * - - - - -	4,6	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
G 01 P

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	03 January 91	HANSEN P.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same catagory
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention

E: earlier patent document, but published on, or after the filing date
D: document cited in the application
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&: member of the same patent family, corresponding document